REMARKS/ARGUMENTS

Claims 1-28 and new claims 41-42 are pending in this application. Claims 1-28 and 39 have been rejected. Claims 29-32 have been withdrawn from prosecution, and are now canceled. Claims 33-38 and 40 were previously canceled. Claims 1, 6-8, and 22 have been amended, and claims 29-32 and 39 have been canceled, to more particularly point out and distinctly claim the subject matter of the present invention. Applicant hereby requests further examination and reconsideration of the application in view of the foregoing amendments and these remarks.

In paragraph 3 of the Office Action, the Examiner rejected pending claims 1-28 and 39 under 35 U.S.C. § 112(2). The Examiner stated that: (a) in claim 1, lines 10-11, "a multiple reflectivity band reflector (MRBR) coupled to at least a portion of laser light emitted from the laser" is indefinite; it is unclear as to how the MRBR is to be coupled; (b) claim 22, lines 4-5, "coupling a multiple reflectivity band reflector (MRBR) to at least a portion of laser light emitted from the laser" [Applicant notes that the text actually reads: "... at least a portion of the emitted laser light"]; (c) claim 39 sets forth a list of elements but fails to provide any structural relationship between the recited elements; intended results are set forth but the structure recited in the claim is insufficient to support the intended results.

As explained in the Specification:

> In an embodiment, the **MRBR of the present invention** (e.g., the embodiments illustrated in Figs. 1-5 above) is employed in a laser apparatus **for laser wavelength monitoring purposes**, in accordance with an embodiment of the invention. As used herein, "monitoring" includes monitoring, controlling, tuning, selecting, and locking the output lasing wavelength of a given semiconductor laser with the use of the reflectors of the present invention. The MRBR is part of the laser cavity itself, in some embodiments, or is used outside the cavity for monitoring and locking purposes in other embodiments.
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> Referring now to Fig. 8, there is shown an embodiment of the semiconductor laser with MRBR wavelength monitoring of the present invention. As illustrated in Fig. 8, a tunable edge-emitting laser 810 has an **exit mirror 814** (with AR coating) and an **HR** (high reflectivity, but less than 100%) **mirror 816**, which define the **laser cavity 812**. In an embodiment, the laser 810 can emit over a wavelength range covering several ITU wavelengths, under the control of a variable tuning parameter (e.g. temperature, gain, current, etc.). One or more monitoring photodiodes, e.g. 826a, 826b, detect some of the cavity light 822 passing through the HR mirror 816.
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> **An MRBR 824 covering the tuning range of the laser is used as a filter, to monitor the lasing wavelength and channel.** In an embodiment, the MRBR 824 is a coating on a light-receiving surface of one of the photodiodes 826b, so that the photodiode 826b receives light filtered by the MRBR 824. In another embodiment, the MRBR 824 is not coated on the photodiode 826b, but is **in the path f light 822 from the laser 810 t the photodiode 826b.** The MRBR 824 preferably has a plurality of narrow reflectivity bands, preferably closely and substantially evenly spaced, over the tuning range of a given laser 810 whose wavelength is to be monitored, with each discrete target

> wavelength of the laser 810 corresponding to one of the MRBR 824 reflectivity bands' center wavelength.
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> Each of the photodiodes 826a, 826b is monitored by a corresponding circuit 828a, 828b. The amount of the light 822 transmitted through the HR mirror 816 that reaches the photodiodes 826a, 826b corresponds to a change in electrical characteristics of the photodiodes 826a, 826b. In one embodiment, the current flowing through photodiodes 826a, 826b changes in response to the amount of light 822 received. The circuits 828a, 828b detect the change in electrical characteristics and report that change to a processor 830. In on embodiment, a single circuit performs the functions of 828a, 828b, and 830.
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> In an embodiment, there is a one-to-one correspondence between the MRBR 824 reflectivity bands and the desired selectable (tunable) wavelengths of the laser 810. In other embodiments, the MRBR 824 can have other reflectivity bands between the target wavelengths, so long as the locking algorithm is sophisticated enough to take the "extra" reflectivity bands into account when locking and changing wavelengths.
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> Monitoring photodiode 826a is of the type typically used to monitor for power, in a feedback loop which controls current powering the laser 810 (to maintain a constant output power). However, **light reaching 826b is first filtered by passing through the MRBR 824, which is coated onto the surface of the photodiode 826b.** The reflectivity bands of the MRBR 824 may have approximately 99% reflectivity, at the center wavelength thereof, and 97% or less reflectivity between the bands (troughs). The **HR mirror 816 may have, for example, 99% reflectivity. Thus, the HR mirror 816 transmits out the "back side" of the laser 810 about 1% of the light lasing in the cavity 812. This 1% light 822 impinges on both photodiode 826a and the MRBR 824.** Of the light reaching the coated photodiode 826b, the light is either 99% reflected by a band reflectance, or reflected to a lesser degree if the laser 810 is off band. In another embodiment (e.g., in a preferred embodiment for the embodiment described with reference to Fig. 5A), the photodiode 826b is not coated, but the path of light 822 is through the MRBR 824. If the laser 810 is off band, more light reaches photodiode 826b, than is the case when the laser 810 is on band (locked) because the reflectance of the MRBR 824 decreases as the wavelength varies from the on band frequency for small amounts of variance.
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> Thus, when the laser 810 is properly tuned to emit at one of the desired wavelengths (e.g., one of the ITU wavelengths), only about 1% of the light 822 impinging on the MRBR 824 will be transmitted and reach photodiode 826b. If the wavelength starts to drift out of the reflectivity band, a larger fraction of the light 822 will be passed through the reflector/filter 824. The increase in light detected by photodiode 826b can permit the monitoring circuit/algorithm to determine that wavelength drift has occurred, and to adjust the tuning parameter (e.g., temperature, gain, and/or current) to get back into wavelength lock. [Specification, page 26 et seq., emphasis added; Figs.1-5, 8]

Thus, in this embodiment, an MRBR is "coupled to at least a portion of laser light emitted from the laser" by placing it "behind" the HR "back" or "first" (i.e., non-exit) mirror, so that it is in the path of the small portion of light, e.g. 1% of the light in the cavity. The filtered light from MRBR 824 then is detected by photodiode 826b which, along with monitoring circuit 828b, produces a signal (e.g., electrical current) related to the amount of filtered light reaching the photodiode 826b. That signal can be used by an appropriate monitoring algorithm run by processor 830 to adjust the tuning parameter (e.g., temperature, gain, and/or current) to get back into wavelength lock.

In other embodiments:

> ... the MRBR 824 is not coated on the photodiode 826b, but is instead part of the HR mirror 816 (or coated thereon). Alternatively, other tapping techniques may be employed, e.g. a tap coupler 910, as illustrated in Fig. 9. In the system shown in Fig. 9, the wavelength locker 916 contains the photodiodes 826a, 826b, an MRBR coating photodiode 826b, and suitable circuitry to provide feedback for wavelength locking to the temperature controller 918. [Page 29, lines 12-17; Fig. 9]

Thus, in another embodiment, the MRBR is "coupled to at least a portion of laser light emitted from the laser" by placing it to receive the output of a tap coupler (e.g. 910) which itself receives the light emitted from the exit mirror. Then, as in the embodiment discussed above, the filtered light from the MRBR in wavelength locker 916 is applied to photodiode 826b, which is used as explained above to control the wavelength of the tunable laser with an appropriate parameter controller such as parameter controller 918.

In the above-described embodiments, therefore, an MRBR is positioned to receive a portion of the light that is in the laser cavity, so that it filters that portion of laser cavity light, which can then be applied to a photodetector and appropriate wavelength controlling means responsive to the output of the photodetector. In one embodiment, the MRBR is positioned behind the HR mirror so that it receives the small amount that passes therethrough; in another embodiment, a tap coupler in the path of the light emitted from the exit mirror applies a small percentage of the exit light (the "tapped" portion) to the MRBR. See also originally-filed dependent claims 6-8.

Independent claims 1 and 22 have been amended to clarify that the MRBR is coupled to the laser structure to receive some of the laser light in accordance with the embodiments described in the Specification. Claim 39 has been canceled. The variously dependent claims have been amended pursuant to the amendments to the independent parent claims. Applicant submits that claims 1 and 22, as amended, are clear as to how the MRBR is coupled and provide sufficient structural relationship between the recited elements to support the intended results.

In view of the foregoing remarks and amendments, the pending claims, as variously amended, are believed to be in condition for allowance. Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

The Assistant Commissioner for Patents is hereby authorized to charge any additional fees or credit any excess payment which may be associated with this communication to our deposit account **50-1705.**

The undersigned may be contacted for any questions.

Respectfully submitted,

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